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A WIDEBAND LOW-SIDELobe DISC-O-CONE ANTENNA(U)  
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J L WONG ET AL. 15 JUL 83 TR-0083(3476-04)-1

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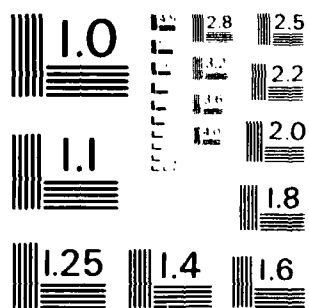
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## A Wideband Low-Sidelobe Disc-O-Cone Antenna

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Electronics Research Laboratory  
Laboratory Operations  
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El Segundo, Calif. 90245

15 July 1983

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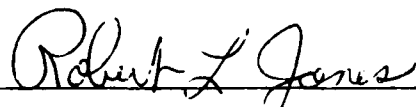
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This report has been reviewed by the Public Affairs Office (PAS) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nationals.

This technical report has been reviewed and is approved for publication. Publication of this report does not constitute Air Force approval of the report's findings or conclusions. It is published only for the exchange and stimulation of ideas.



Robert Jones, Captain, USAF  
Project Officer



Norman W. Lee, Jr., Colonel, USAF  
Commander, Det 1, AFSTC

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PREFACE

The authors wish to thank the GPS Program Office for supporting this study. They also wish to thank O. L. Reid, A. J. Illingworth, and L. U. Brown for construction and testing of the disc-o-cone antennas.

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## CONTENTS

PREFACE.....	1
I. INTRODUCTION.....	7
II. DESIGN DESCRIPTION.....	9
III. GAIN AND PATTERNS.....	11
IV. CONCLUSIONS.....	13
REFERENCES.....	15

## FIGURES

1.	Typical Disc-O-Cone Antenna Geometry.....	10
2.	VSWR of Disc-O-Cone.....	10
3.	Gain of Disc-O-Cone.....	12
4.	Typical Measured Patterns.....	12

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## I. INTRODUCTION

A disc-on-rod or cigar antenna is an endfire antenna, composed of a series of concentric metallic discs on a rod.<sup>1</sup> When the disc diameter and spacing are properly chosen, the antenna produces an endfire pattern similar to a helix and the sidelobe level varies typically from -10 to -15 dB. To improve the sidelobe characteristics, the disc diameters may be tapered along the rod and a short axial-length funnel may be used in conjunction with the feed or launcher. Sidelobe levels of -15 to -20 dB have been reported.<sup>1,2</sup>

The present antenna design consists of a disc-on-rod housed in a conical horn with a relatively large flare angle. The combined antenna configuration provides broadband gain and pattern characteristics with peak sidelobe levels of  $\sim -30$  dB, and it is referred to as "disc-o-cone." The operation of this antenna is similar to that of a helicone antenna.<sup>3,4</sup> However, the use of a disc-on-rod, instead of a helix, offers additional flexibilities for a low-sidelobe antenna design. The disc diameters are made nonuniform along the rod and the design parameters such as the axial length, disc diameters, number of discs and spacing between discs can be varied easily. Furthermore, variable-polarization operation can be achieved by appropriate design of the feed or launcher. The disc-o-cone antenna was designed for possible application with the Global Positioning System (GPS) operating within the 1200 to 1600 MHz band. Thus, most of the measurements were made in this frequency range.

## II. DESIGN DESCRIPTION

Figure 1 shows a typical disc-o-cone antenna geometry. Except in the feed region, the discs are uniformly spaced at 2.04 in. and the disc diameter tapers from 3 in. to 2 in. at the end. For experimental purposes, a 24.75 in. diameter  $\times$  21.73 in. length horn with a  $45^\circ$  flare angle was chosen. These horn dimensions are slightly less than those of an optimum-horn design. It should be mentioned that an isolated conical optimum horn generally has a peak sidelobe level of  $\sim -12$  dB.

To provide broadband operations, the disc-o-cone antenna was fed with a cavity-backed, open-sleeve crossed dipole<sup>5</sup> as depicted in Fig. 1. Two 2.75-in. diameter open sleeves (not part of disc-on-rod) spaced 0.40 in. from the dipoles are employed. These circular open sleeves provide a natural transition to the disc-on-rod antenna. For circular polarization, the orthogonal dipoles are connected to a  $90^\circ$  hybrid. The measured VSWR characteristics of the individual dipoles (linear polarization) are shown in Fig. 2. The presence of the horn has relatively little effect of the VSWR performance. Typically, the VSWR is  $<1.8:1$  from 1.2 to 1.6 GHz.

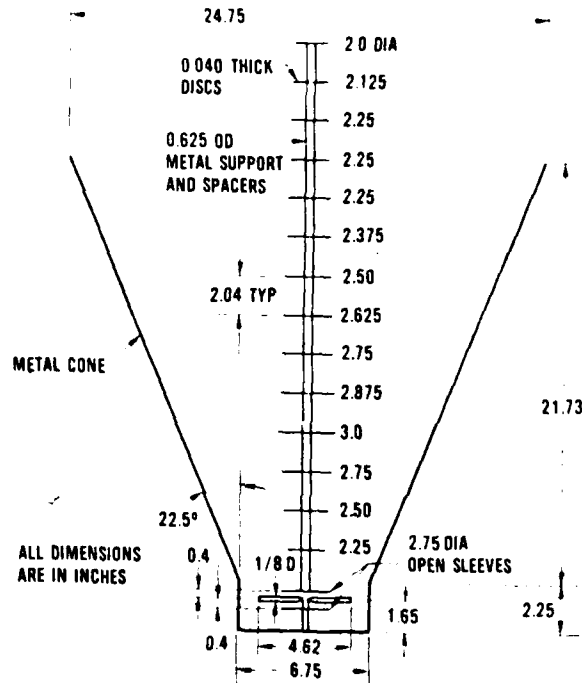


Figure 1 Typical Disc-O-Cone Antenna Geometry

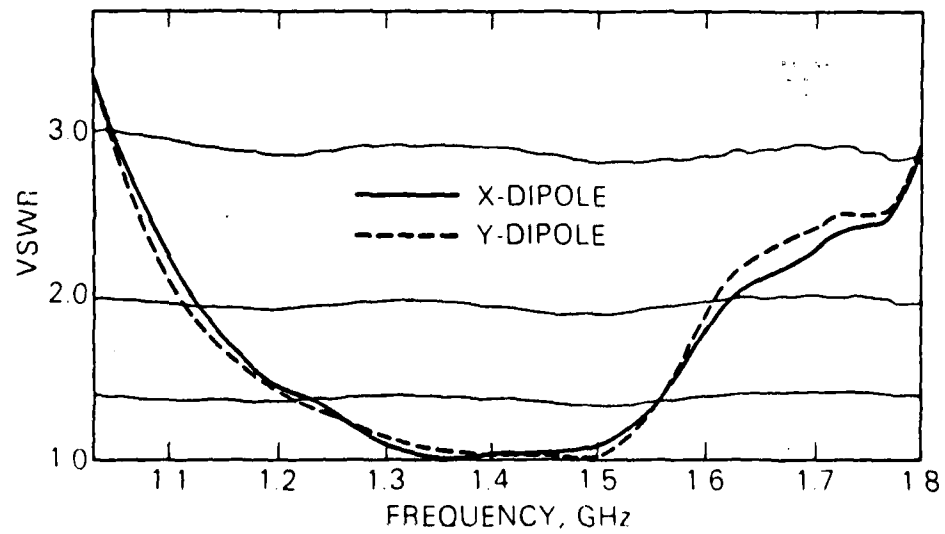


Figure 2 VSWR of Disc-O-Cone

### III. GAIN AND PATTERNS

The measured gain and typical patterns of the disc-o-cone antenna are shown in Figures 3 and 4, respectively. The gain response is relatively flat ( $\pm 1$  dB) from 1.1 to 1.7 GHz. The patterns were taken with a rotating linearly-polarized source. The axial ratio is  $< 1$  dB, and the sidelobes and backlobes are generally  $< -27$  dB over the measurement frequency range, providing substantial improvement over an isolated disc-on-rod or horn antenna.

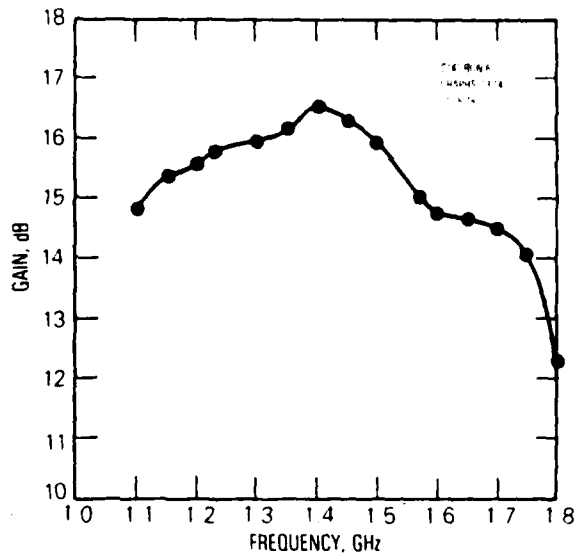


Figure 3 Gain of Disc-O-Cone

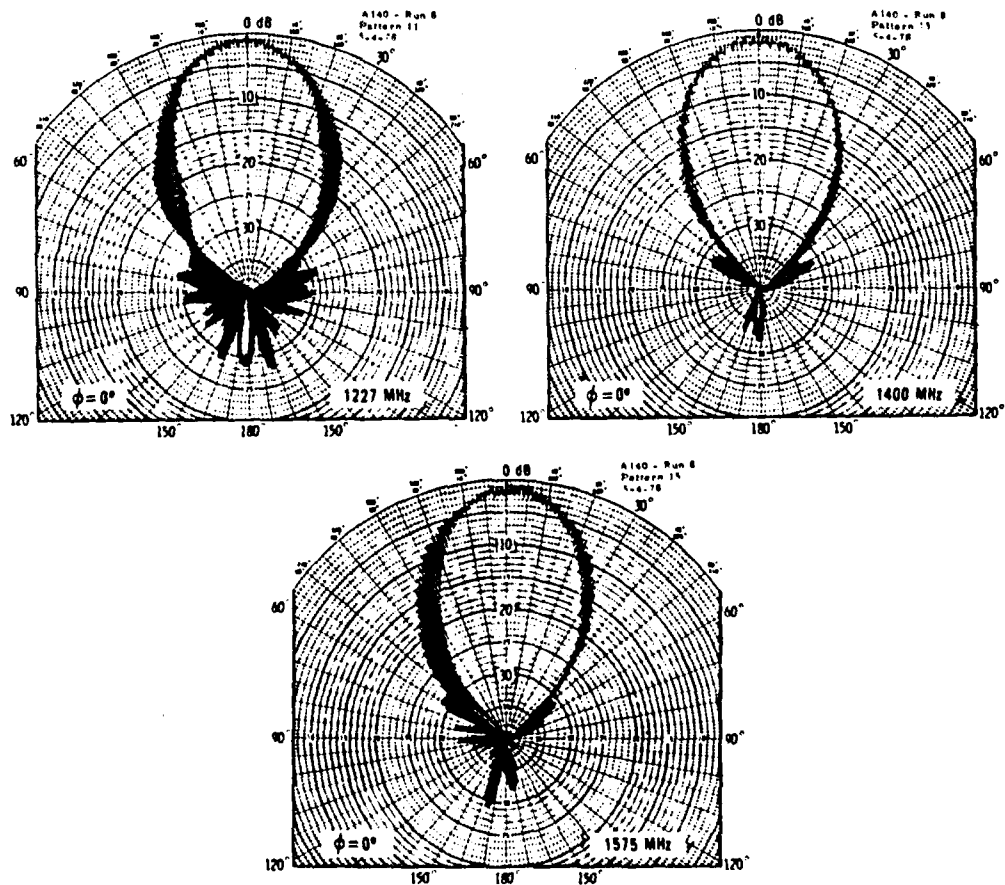


Figure 4 Typical Measured Patterns

#### IV. CONCLUSIONS

A combination of a conical horn and a disc-on-rod antenna has been shown to yield extremely low sidelobe levels (peak sidelobe  $\sim -30$  dB) over a 1200 to 1600 MHz bandwidth. The combination eliminates the poor sidelobe characteristics of the individual isolated antennas. The disc-o-cone has the flexibility of varying the disc diameters, the disc spacing, and the number of discs to optimize the sidelobe performance over a wide bandwidth.

#### REFERENCES

1. J. C. Simon and G. Weill, "A New Type of Endfire Antenna," Annales de Radioelectricite, Vol. 8, July 1953.
2. S. A. Brunstein and R. F. Thomas, "Characteristics of a Cigar Antenna," JPL Quarterly Technical Review, Vol. 1, No. 2, July 1971, pp. 71-94.
3. K. R. Carver, "The Helicone - A Circularly Polarized Antenna with Low Sidelobe Level," Proc. IEEE, April 1967, p. 559.
4. K. R. Carver and B. M. Potts, "Some Characteristics of the Helicone Antenna," Digest - 1970 IEEE International Symposium on Antennas and Propagation, pp. 142-150.
5. J. L. Wong and H. E. King, "Broadband Characteristics of an Open-Sleeve Dipole," Digest - 1972 IEEE International Symposium on Antennas and Propagation, pp. 332-335; also, "Design Variations and Performance Characteristics of the Open-Sleeve Dipole," The Aerospace Corporation, TR-0073(3404)-2, 15 January 1973 (SAMSO TR 73-133).



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